THE USE OF *SOLANUM NIGRUM* FOR THE UPTAKE OF ZINC ASSISTED BY DIFFERENT ARBUSCULAR MYCORRHIZAL FUNGI

Ana P. G. C. Marques(1), Rui S. Oliveira, António O.S.S. Rangel and Paula M. L. Castro
Escola Superior de Biotecnologia, Universidade Católica Portuguesa
Rua Dr. António Bernardino de Almeida, 4200-072 Porto, Portugal
(1)amarques@mail.esb.ucp.pt

PHYTOREMEDIATION OF TOXIC METAL CONTAMINATED SOILS

Pollution of the environment and the non controlled migration of the contaminants have increased dramatically since the birth of the industrial revolution, causing serious damage on ecosystems and affecting public health. These and other reasons bring up the need for new solutions of remediation. Phytoremediation is an emergent technology that uses plants to remove, degrade or immobilize the contaminants, offering a low cost method for soil remediation.

The experience in this field suggests that collecting plant species existing in contaminated soils may be effective for selecting potential plants to use in phytoremediation. The region of Estarreja appears as a strong candidate for this kind of research as for many years, several chemical facilities of the region have discharged its solid residues in an improvised park in the surrounding area, and conducted its wastewaters into a stream nearby ("Esteiro de Estarreja"). In spite of the levels of zinc (amongst other metals as Pb, Hg and As) remaining above the limits established by the european legislation in the sediments of this stream (to a depth of 50 cm) and of the high permeability of the soils in the area, the vegetation remains proliferous on the banks of the stream.

Arbuscular mycorrhizal fungi (AMF) are soil microorganisms that form symbiotic associations with plant roots. This association works through the aid that AMF offer to the plants by capturing mineral nutrients from the soil (which may include metals as Zn), participating in the improvement of the plant growth and reproduction. Plants function in this association is accomplished by the offering of carbohydrates. The role of AMF in phytoremediation of heavy metals is not clear and the analysis of these rhizosphere interactions seems to be a promising patch for the optimization of the plant uptake.

The purpose of this study was to use a plant species indigenous to this site- *Solanum nigrum* (black nightshade)- in a growth experiment under Zn and AMF exposition, consisting of black nightshade plants submitted to several Zn concentrations (in a sand matrix with applied zinc to the 100, 500 and 1000 mg Zn/kg dry sand and in contaminated soil collected from the banks of "Esteiro de Estarreja") and inoculated with pure and mixed cultures of 4 AMF isolated from heavy metal contaminated sites. The determination of the Zn levels present in the growth matrixes and in the plants roots, shoots and leaves for the different metal and AMF exposure conditions will allow to establish a relation of the metal contamination in the soils with the concentrations in the plants and its colonization by different AMF.

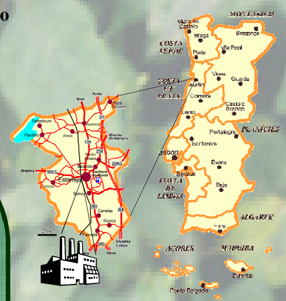


Fig.1: Location of the studied region

Fig.2: General view of the stream

Fig.3: General view of the growth experiment

Zn= 0 ppm matrix=sand					
fungus A	fungus B	fungus C	fungus D	mixture	no fungus

Zn= 100 ppm matrix=sand					
fungus A	fungus B	fungus C	fungus D	mixture	no fungus

Zn= 500 ppm matrix=sand					
fungus A	fungus B	fungus C	fungus D	mixture	no fungus

Zn= 1000 ppm matrix=sand					
fungus A	fungus B	fungus C	fungus D	mixture	no fungus

Soil from the banks of Esteiro de Estarreja (Zn= 426± 2 ppm)					
fungus A	fungus B	fungus C	fungus D	mixture	no fungus

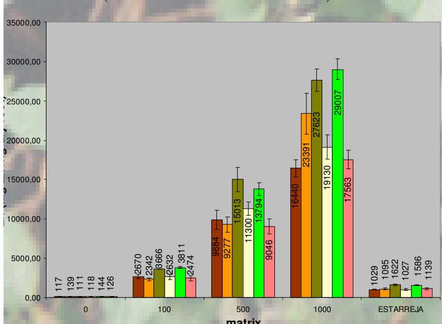
Fig.4: Scheme of the growth experiment. The inoculated fungus are: A - *Glomus* sp. BEG140 (isolated from a Mn contaminated soil); B- *Glomus claroideum* (isolated from a Cd and Zn contaminated soil); C - *Glomus mosseae* (isolated from a Cd and Zn contaminated soil); D- *Glomus intraradices* (isolated from a Pb contaminated soil).

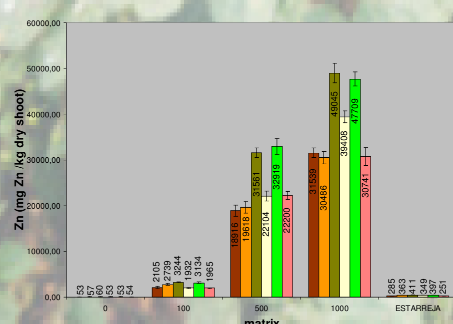
MATERIALS AND METHODS

The growth experiment was set according to the scheme presented in Figure 4. After reaching the maturity of the individuals, the plants were harvested and treated according to the following method .

Separation of roots, shoots and leaves → Washing → Drying → Grinding → Hot acid digestion → AAS analysis of the digests → Zinc level data

Washing → Collection of fresh roots samples → Mycorrhizal colonisation analysis





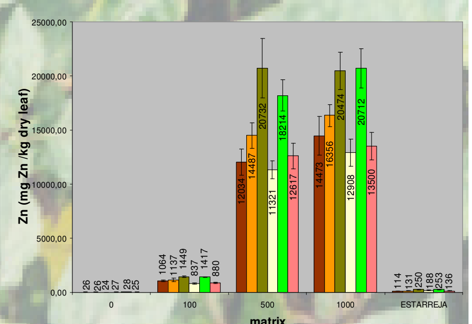


Fig.6: Accumulation in *S.nigrum* roots, shoots and leaves.

No fungus Fungus A Fungus B Fungus C Fungus D Mixture

RESULTS AND CONCLUSIONS

-In the sand matrix, a crescent zinc concentration of the soil resulted in a crescent accumulation in the different parts of the plants;

-For the same zinc concentration in the matrix, the metal accumulation in *S. nigrum* roots, shoots and leaves was always higher for the fungi B and D inoculations;

-Nevertheless the total zinc content in the soil from the banks of "Esteiro de Estarreja" is higher than 100 ppm, the accumulation obtained for the plants grown in this matrix is lower then the one registered for the individuals grown in the Zn 100 ppm matrix; this is probably due to a lower availability of the metal in this kind of organic matter rich matrix

Through all the results obtained, it is possible to conclude that black nightshade appears as a potential zinc accumulator and that different arbuscular mycorrhizal fungi have different influences in the zinc accumulation by the plant. For all this, *Solanum nigrum* presents itself as a good solution for the contamination problems of "Esteiro de Estarreja" area.

ACKNOWLEDGEMENTS

The authors wish to thank Câmara Municipal de Estarreja for the permission of access to the site and Miroslav Vosátka for providing the AMF isolates used in the work. This work was supported by Fundação para a Ciência e a Tecnologia, research grants of Ana Marques (SFRH/BD/7030/2001) and Rui Oliveira (SFRH/BD/1464/2000).